

ABSTRACT OF THE DISCLOSURE

A field effect transistor can include a vertical channel protruding from a substrate including a source/drain region junction between the vertical channel and the substrate, and
5 an insulating layer extending on a side wall of the vertical channel toward the substrate to beyond the source/drain region junction. The transistor can also include a nitride layer extending on the side wall away from the substrate to beyond the insulating layer, a second insulating layer extending on the side wall that is separated from the channel by the nitride layer, and a gate electrode extending on the side wall toward the substrate to beyond the
10 source/drain region junction. Related methods are also disclosed.